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Designs of a fire detecting and fire pre-warning system based on single chip microcomputer

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Abstract

The paper mainly deals with the design of hardware for an automatic fire fighting system, which aimed at closed combustible places. This system adopts single chip microcomputer with smoke sensor and temperature sensor as the detective devices. By using the single chip microcomputer, it can achieve the aim of automatic fire fighting. And, this system uses high pressured nitrogen as the fire extinguishing agent, which is economical and environment friendly. It accords with the human's needs of environmental protection.

Key words: Single chip microcomputer; Fire detection; Sensor; A / D converter;

1. Introduction

The use of fire has promoted the development of human society and civilization. But, fire out of control, i.e., fire hazard, has posed a serious threat to human life and property, and damaged greatly to the ecological environment that human survival depends on. In order to prevent fires and reduce fire losses, it has a great importance to develop a practical control system that integrating the functions of intelligent fire detection and automatic fighting.

Compared with existing fire alarm systems, this system has the following characteristics. First, by integrating the detection functions of temperature sensor and smoke sensor, it can reduce the omission rate and false alarm rate. Second, the system can monitor flammable places conveniently due to the human-computer interaction system. Third, the system can realize multi-point data logging and enlarge alarm range. Last, the usage of high-pressure nitrogen gas to extinguishing fire does not spoil the environment and has good economic returns.

2 Working principle of the system

2.1 Parameters for fire detection

This system chooses smoke and temperature as fire detection parameters. It has a complex fire detecting system composed of the smoke detector and the thermal detector. Composite detection can eliminate the interference and false alarm caused by non-fire signals which haven't multiple signal parameters of the real fire. These signals include dust, water, gas and tobacco smoke.

2.2 The overall system plan design

The principle of the single chip microcomputer based automatic alarm and fire extinction system is shown in Figure 1. The system can be divided into two modules: signal acquisition module and signal processing module.

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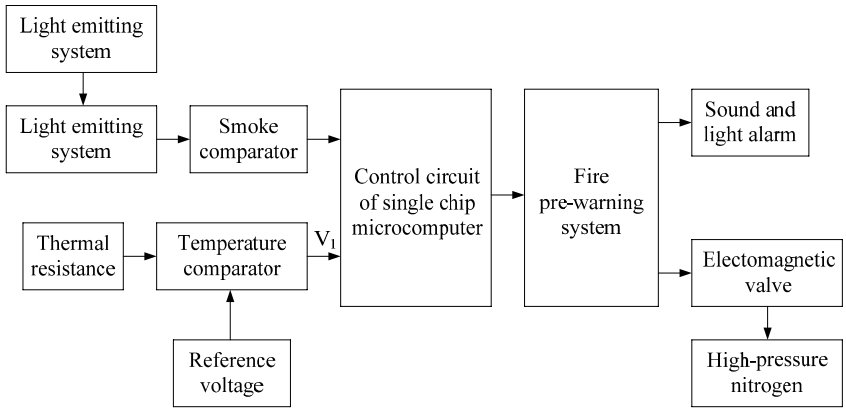

Figure 1. The diagram of working principle of the system

2.2.1 Signal acquisition module

Signal acquisition module consists of smoke detector, temperature detector and signal processing circuit.

Smoke detector is mainly made up of infrared light-emitting diode and phototransistor. The light source is an infrared light-emitting diode, which generates high-frequency infrared radiation pulses by oscillation circuit. Phototransistor is fixed with a certain distance to the light emission point as an infrared receiver. When the fire occurs, a certain concentration of smoke enters the smoke detector. Then the intensity of the infrared light that the phototransistor received decreases, and the resistance of phototransistor increased. So the transistor becomes conductive. After signal processing, the output voltage V_1 decreases greatly.

In the temperature detector, a thermistor with the positive temperature coefficient is used. After the fire occures, the temperature signal voltage V_2 increases slowly along with the indoor temperature.

2.2.2 Signal processing module

The control part consists of the two major functional modules: A / D converter, the 8279 keyboard and the interface of the monitoring module. See figure 2.

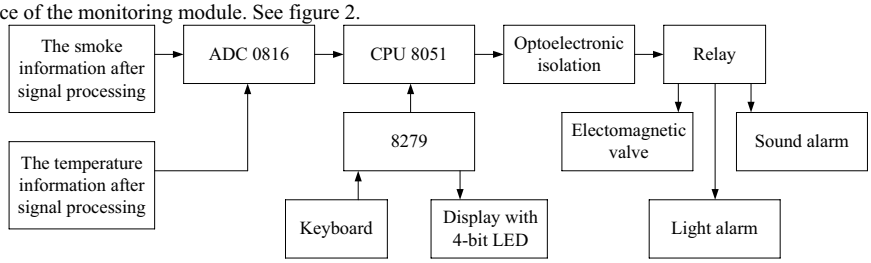

Figure 2. The diagram of control circuit of the single chip microcomputer system

The smoke signal and the temperature signal after preamplifier get into the A / D converter. ADC0816 converts the analog signal into digital signal and sends to the CPU, which compares the digital signals with the settings in the program and determines whether to open the optical isolation so as to control the relays. These relays achieve optical alarm, sound alarm and high-pressure nitrogen gas fire-extinguishing.

Connecting the 8279 chip with the CPU, an interface is expanded with a keyboard and an interface circuit of Monitor. The value of the alarm temperature is input through the keyboard and it will display on LED. Therefore, it achieves human-computer interaction and embodies the intelligence, which is another advantage of using microcomputer.

3 Microcontroller circuit design

The schematic diagram of the control circuit has been shown in Figure 2. It is mainly made up of the 8051 chip, 16-channel A / D converter ADC0816, a 4 × 4 keyboard, a 4-bit LED displayer and other interface chips. In order to improve anti-jamming capability, several anti-jamming systems are designed relatively.

3.1 The design of the interface between ADC0816 and 8051 chip

In the system, interface circuit of ADC0816 and 8051 hardware uses interruption and is shown in figure 3. By using this method, the main program could proceed after CPU start the A / D conversion. When the A / D conversion ends, it sends a signal EOC as the end of the conversion, which will be received by INT1 end of the 8051 after an inverter, and then an interrupt request to the CPU will be sent. After the CPU responds, the data will be read and processed.

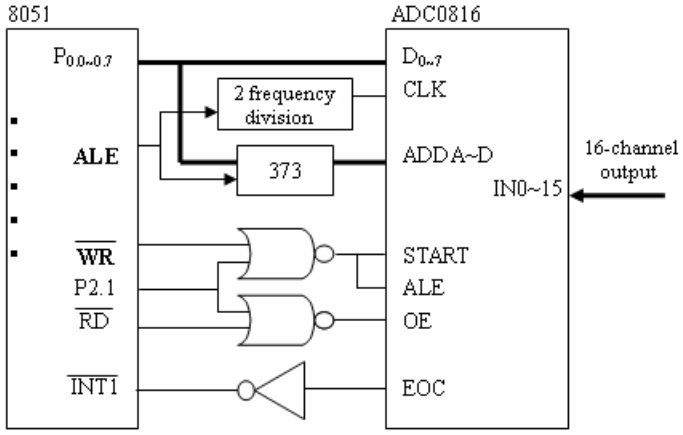

Figure 3. The circuit of the interface between ADC0816 and 8051 chip

The starting signal START of ADC0816 is produced by chip-selecting line P2.1 and the "NOR" from the writing signal WR. ALE connects START, i.e., the analogue information is decided by the input channel selected and the conversion starts. The output enable signal OE is decided by the reading signal RD and the "NOR" from the chip-selecting line P2.1. The output of the data is followed by a reading operation from ADC0816. The conversion ending signal EOC "NOT" connects with the INT1 of 8051. At the ending of the conversion, EOC turns from 0 to 1. At last INT1 is 0 and the interrupt is open.

According to the line selection and decoding connection in figure 3, the addresses of ADC0816 analog channel 0 to 16 are duplicated. One assigning method is: FDF0H ~ FDFFH. The input voltage VIN = D * VREF/255 = 5D/255.

3.2 The design of keyboard interface circuit

In the process of designing the keyboard interface circuit, the number of buttons, functions and corresponding wiring are decided according to the digital input and control functional requirements. There are 16 operation keys on the keyboard and the arrangement is 4 × 4. The usable 14 operational keys are:

- The number keys are labeled 0 ~ 9.
- "ENT" key: Pressing the key can make the system work after parameter setting and changing.
- "CLR" key: When modifying the alarm temperature is needed, pressing the key can clear the displayer.
- "STP" key: In the process of the system alarm, pressing the key may shut down the alarm bell and close the high-pressure nitrogen gas control valve.
- "RST" key: It is used for system reset.

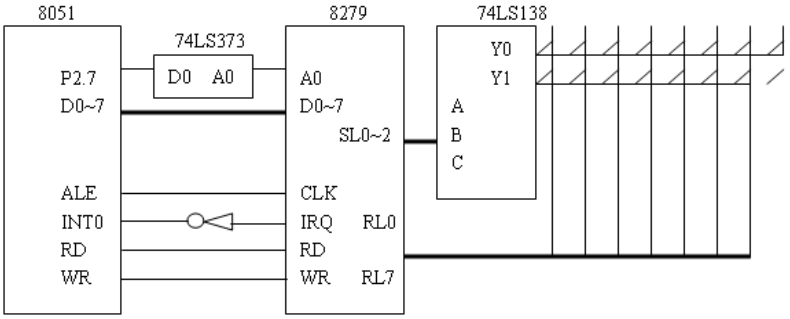

Figure 4. The circuit of keyboard interface

The keyboard interface circuit is shown in Figure 4. Three scan lines SL0 ~ SL3 are used. These scan lines are decoded by 3-8 decoder 74LS138 and the decoder outputs lines Y0, Y1. The two lines and the eight return lines of 8279 build a 2 × 8 matrix. Since the 16th key is the reset button, it does not connect with 8279. When the buttons (4 × 4) connect with the matrix, 8279 set them continuous key values from 0 to 15. In particular, the number keys 0 to 9 are consistent with the values represented by themselves. This property greatly facilitates the design of key processing. According to the key inputs, 8279 notify the microcomputer to handle by interruption.

3.3 The design of display interface circuit

The main usage of the displayers includes LED (light emitting diode display) and LCD (liquid crystal display). Both the displayers are low-cost, configuration flexible, and facilitate to the microcontroller interface comfortably. LED displayer is used in this design.

In the interface circuit of the monitor shown in figure 5, two output lines OUTB0 ~ OUTB3 and OUTA0 ~ OUTA3 in 8279 are connected to segment-select-side of a common cathode LED through two reverse driver chips 7404 of six bite input-output. So it can input segment-select-code. There are totally 4 LED displayers, so 8279 is an 8 character displayer. Its scan lines SL0 ~ SL2 output signal in a way of coding, and it drives chip 74LS138 to achieve bit-selection control on the monitor through the 3-8 line decoder. 8279 status / control port is 7FFFH and the data port is 7FEFH.

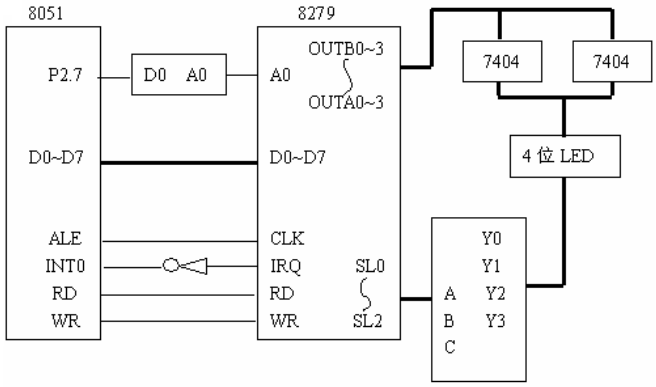

Figure 5. The circuit of the interface to the monitor

4 The software design of the system

The system needs to detect the temperature and the smoke signals of the environment and convert then into digital values first. If the values are bigger than the setting ones, fire alarm is executed with sound and light. At the same time, the high-pressure nitrogen gas control valve is activated to extinguish the fire.
The flow chart of the software system is shown in figure 6.

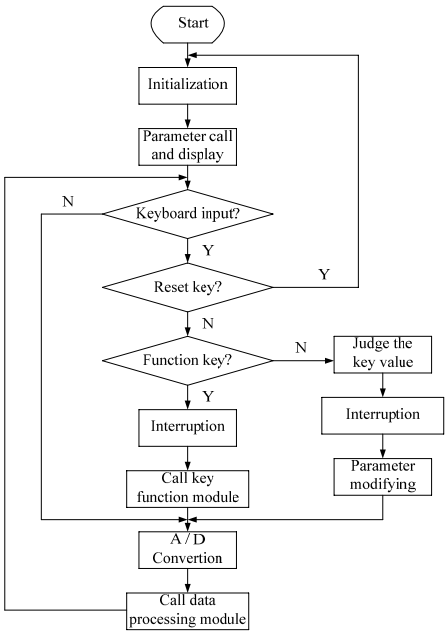

Figure 6. The flow chart of the software

5 Conclusion

Burning fire is a complex phenomenon with a variety of characterization parameters. It is difficult to simultaneously obtain high accuracy and wide range of adaptability when detecting at the early stages just through a single parameter measurements. The fire detection technology in this paper reflects more accurately the true comprehensive characteristics of fire phenomena by using a complex detector composed of sensory of temperature detector and smoke detector. So it could judge comprehensively about fire smoke, temperature, light and other multiple relative parameters, and achieve the pre-disaster detection and alarm effectively. The system achieves control of the hardware circuit by using the interface to the microcomputer so as to make the detection more intelligent. The fire detection could meet people's requirements of safety on the fire to a greater degree. It can be widely used in many industries with significant economic and social benefits.

Acknowledgement

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